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(54) Title of invention: Porous grinding wheel for grinding rolling roll made of high speed tool steel

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PATENT SPECIFICATION

1. TITLE OF INVENTION

Porous grinding wheel for grinding rolling roll made of high speed tool steel

2. CLAIMS

In grinding wheel for grinding rolling rolls that is constructed with high speed tool steel at least for their surface layer,

this invention is porous grinding wheel for grinding rolling roll made of high speed tool steel which is characterized that pores of mean diameter 1 to 10 times of diameter of grinding mineral is provided in a ratio of 14 to 60 volume parts to 100 parts of the grinding mineral, using materials that generate pores, and the grinding mineral ratio is made to be 30 to 42 percent.

3. DETAILED DESCRIPTION OF THE INVENTION

Industrial application field

This invention concerns porous grinding wheel for grinding rolling roll made of high speed tool steel.

Prior technologies

In modern hot rolling process of steel, new processes such as low temperature high pressure rolling and highly shape controlled rolling are being introduced due to the requirements of such as productivity improvement and quality improvement of steel materials. Among those processes there is a process that is described in publication of Utility Model Right disclosure 62-131705, for example. According to this, either side of upper or lower rolling roll is made in smaller diameter and at the same time, the small diameter rolling roll is bent so that the middle section of it shifts toward upper stream of the flow of rolled material.

Because this type of roll has higher rotational speed due to its smaller diameter, there has been a disadvantage that amount of wear is grater if it is made of previous roll material and frequent replacement of the roll is required in order to maintain the quality of steel sheet. Therefore, in order to solve above disadvantage, rolling rolls made of high speed tool steel have been proposed.

Problems that the invention is to solve

In order to handle the local wear accompanied with the used of said rolling roll, re-shaping of circumference surface is done by periodically grinding the circumference surface of the rolling roll. However, there have been a problem that when the rolling roll made of high speed tool steel is ground with resinoid type wheel that is used for grinding rolling rolls of previous materials such as adamite roll or high alloy grain roll, the grinding ability is significantly reduced, and chattering patterns and scratches related with dropout of grinding minerals become significant which prevents from obtaining a good ground surface.

After several considerations with above described background, it was discovered that excellent grinding property on rolling rolls made of high speed steel is obtained when such as CBN or SiC are bonded using petrified bond while pores and grinding mineral are mixed in specific volume ratio. This invention was done based on this knowledge.

Means to solve the problems

Namely, the summary of this invention is that in grinding wheel for grinding rolling rolls of which at least surface layer is structured with high speed tool steel, pores having mean diameter in 1 to 10 times of grinding mineral is formed using pore-forming material, in a ratio of 14 to 60 volume parts to 100 parts of grinding mineral and the grinding mineral ratio is made to be 30 to 42 (%).

Function and effect of this invention

With this structure, because the carbon silicate grinding mineral is firmly held with the inorganic binder, it strongly bite into the surface of rolling roll, and on the other hand, as a result of large pores equal to or greater than the grinding mineral being mixed to exist in appropriate ratio, clogging is prevented, and further, because grinding mineral is mixed in appropriate ratio so that grinding mineral ratio is within specific range, favorable grinding capability is obtained. Therefore, excellent grinding capability is obtained against rolling rolls constructed with high speed tool steel and the ground surface in good quality is obtained as well.

In the above described rolling roll made of high speed tool steel, the high speed tool steel that composes at least its surface layer is a group of steel specified in a symbol SKH in JIS G 4403, for example, and especially steel which is further improved with wear resistance by increasing vanadium (V) and carbon (C) contents is favorably used.

Further, the artificial pores, that are mixed in to exist in said grinding wheel, are made so that their mean diameter is within a range of 1 to 10 times of the mean diameter of the grinding mineral, preferably within a range of 1 to 3 times, and made to be within a ratio of 14 to 60 volume parts to 100 parts of grinding minerals. If the pores are smaller than 1 time of the mean diameter of said grinding mineral or less than 14 volume parts against 100 parts of grinding mineral, cutting ability is poor, clogging will happen that prevents obtaining good ground surface quality, and on the other hand, if pores are greater than 10 times of the mean diameter of said grinding mineral or greater in volume than 60 volume parts against 100 parts of the grinding mineral, non-uniformity of distribution of pores is significant to become non-uniform grinding wheel which tends to cause chattering or feed pattern.

Said pores are formed by mixing in particle shape pore-forming materials such as styrene resin, polyester resin, epoxy resin, naphthalene, walnut particles and wood chips in specific ratio and burning off the pore-forming material in baking process, in similar diameter of the pore-forming material, and the volume ratio of the pores is determined by the mixing ratio of the pore-forming material.

Further, the grinding mineral that is mixed to exist in said grinding wheel is made to have the grinding mineral ratio to be 30 to 42 (%). When the grinding mineral ratio is less then 30 (%), grinding ability will be reduced, and on the other hand if the grinding mineral ratio is greater than 42 (%), skidding phenomenon would occur to cause clogging, which reduces grinding efficiency.

Example

One example of this invention is described in detail in the following.

Figure 1 shows a rolling roll 10 which is to be ground. As it is apparent by the drawing, the rolling roll 10 is constructed with shaft material 12 comprising strong structural alloy steel and high carbon high speed type outer layer material 14 which is adhered with continuous building up process (casting around process) on its outer circumference surface, and residual compression stress is applied in the high carbon high speed type outer layer material and its surface. Among high speed tool steel, this high carbon high speed type outer layer material 14 is improved with its abrasion resistance by making its hardness to be approximately 1100 Hv by adding large amount of carbon and vanadium, and composed with following component ratio for example.

carbon C:	1.5 - 3.2 %
chromium Cr:	2.0 - 7.0 %
molybdenum Mo:	2.0 - 9.0 %
vanadium Va:	3.0 - 15.0 %
tungsten	3.0 - 20.0 %

The grinding wheel 16 of this example is produced by; mixing 100 weight parts of GC grinding mineral 18 in grit size 36, 19 weight parts of inorganic binder 20 and 10 weight parts of temporary binder; then uniformly mixing in 11 parts of naphthalene pellets as pore generator material; applying press forming by placing in a press mold; and then baking at a temperature about 1100 °C. Figure 2 is a partial cross section of the grinding wheel 16 after baking, and artificially formed pores 22 are mixed to exist in the same size of naphthalene particles after said naphthalene has disappeared. Said inorganic binder 20 is inorganic petrified bond for binding said GC grinding mineral 18 at baking, and pre- formulated with such as feldspar, potter's stone, clay and talk so that it melts well, and composed with following ingredients ratio, for example.

SiO_2:	60 %
Al_2O_3:	20 %
CaO:	2 %
MgO:	2 %
K_2O:	4 %
Na_2O_3:	4 %
B_2O_3:	8 %

Thus produced grinding wheel 16 is made to be binding level G and structure "12", its grinding mineral ratio is made to be 38 (%) and the ratio of artificial pores 22 is made to be 42 volume parts to 100 parts of grinding mineral. Further, as shown in Figure 2, there are many natural pores 24 exist in the grinding wheel 16 which are formed related with loss of such as temporary binder and are much smaller

than the grinding mineral 18, as same as previous grinding wheels. Therefore, the ratio to entire grinding wheel 16 would be in volume ratio of 38 for grinding mineral 18, 16 for artificial pores 22, 9 for inorganic binder 20, and 47 for natural pores 24, for example.

In the following, a grinding test using said grinding wheel 16 is described.

<Example 1>

Table 1 shows the grinding wheel that was used for above described grinding test. No. 0 is a previous grinding wheel for grinding rolling rolls, No. 1 is the grinding wheel 16 of this example, and No. 2 is a resinoid grinding wheel made for this grinding test.

Table 1

Type of wheel	Mineral	Grit	Binding level	Structure	Binder
No. 0	GC	36	H	8	B
No. 1	GC	36	G	12	V
No. 2	GC	36	I	12	B

The grinding test condition is as follows.

(1) Rolling roll to be ground

High carbon high speed steel type rolling roll 10 as shown in Figure 1, 335 mm dia. x 1442 mm, surface hardness: Hs82

(2) Grinding condition

Grinding wheel surface speed: 1150 mpm

Roll surface speed: 40 mpm

Grinding wheel diameter: 915 mpm

(3) Evaluation method

Evaluate with cutting depth in unit time (2 minutes) keeping wheel loading current constant (50 A). Scratches and chattering pattern is visually evaluated.

Table 2 shows results of the test. As it is apparent by the Table, excellent grinding capability is obtained against the rolling roll 10 structured with high speed tool steel and good grinding surface is

obtained at the same time with the No. 1 grinding wheel 16 of this Example. Namely, it is considered that because the GC mineral 18 is firmly supported with the inorganic binder 20, it strongly bite into the external material 14 of the rolling roll 10, and on the other hand, clogging is prevented because pores 22 mixed to exist in appropriate ratio, and further, favorable grinding capability is obtained because mineral 18 is mixed to exist in appropriate ratio so that mineral ratio is within specific range.

Table 2

Type of wheel	Amount of grinding	Scratch mark	Chatter patter
No. 0	0.05 mm	exists	exists
No. 1	0.13 mm	none	none
No. 2	Not able to maintain 50A, generation of maximum wear of wheel, there were many scratch marks.		

<Experiment 2>

In the following, grinding efficiency of said No. 0 grinding wheel and No. 1, against the rolling roll 10 which was used for normal rolling.

The grinding test condition was as follows.

(1) Rolling roll to be ground

High carbon high speed steel type rolling roll 10 as shown in Figure 1 (335 mm dia. x 1442 mm, Hs82) after being used for normal rolling. Namely the one having local wear of 50 to 70 μm (radius) after rolling 500 tons of ordinary steel into a typical rolling size of 2.0 x 900 using a F stand.

(2) Grinding condition

	coarse grinding	intermediate grinding	finish grinding
Grinding wheel surface speed	1150 mpm	1150 mpm	1150 mpm
Roll surface speed	40 mpm	40 mpm	40 mpm
Cutting current	110 Amp.	75 Amp.	40 Amp.
Traverse speed	1.5 mpm	1.5 mpm	0.25 mpm
Grinding wheel diameter	915 mm dia.	915 mm dia.	915 mm dia.

Results shown in Figure 3 were obtained by applying grinding finish to the rolling roll 10 of above (1) following the conditions of above (2) until the dent by wear is eliminated by using the grinding wheel No. 0 and the grinding wheel No. 1. According to this, compared to average 40.9 minutes needed using the grinding wheel No. 0, grinding time was average 28.7 minutes using the grinding wheel No. 1, which provided high grinding efficiency.

As it is apparent by the above Experiment Examples 1 and 2, the scratch marks and chatter patterns were eliminated by the grinding wheel No. 1, namely the grinding wheel 16 of the Experiment Examples, in grinding outer circumference of the rolling roll 10, and at the same time, grinding rate in unit time was increased by approximately 2.6 times; and on the other hand, the grinding time is reduced by up to 30 % when the rolling roll 10 is ground in the same condition, compared with the operation with previous grinding wheel.

4. Brief explanation of drawings

Figure 1 is a drawing that explains a rolling roll which is the grinding object of the grinding wheel in Figure 2. Figure 2 is a drawing that explains the constitution of grinding wheel of one example of this invention. Figure 3 is a graph that shows the results of Experiment 2.

10: rolling roll

16: grinding wheel

18: grinding mineral

20: inorganic binder

22: artificial pores (pores)

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Figure 1

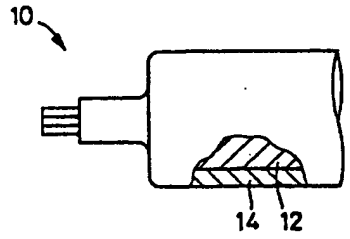


Figure 3

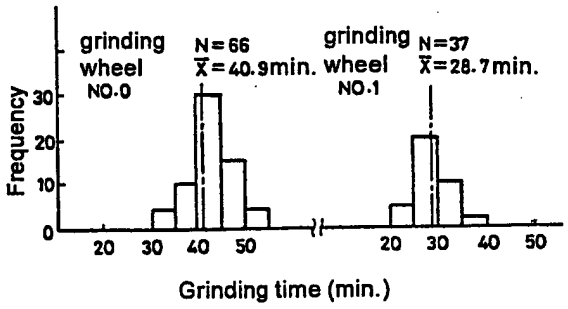
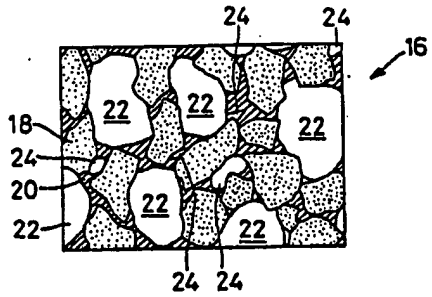


Figure 2



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